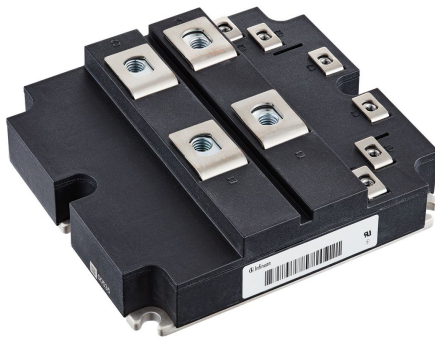


IHM-A 模块 采用第四代沟槽栅/场终止IGBT4和第三代发射极控制二极管  
IHM-A module with Trench/Fieldstop IGBT4 and Emitter Controlled 3 diode



#### 潜在应用

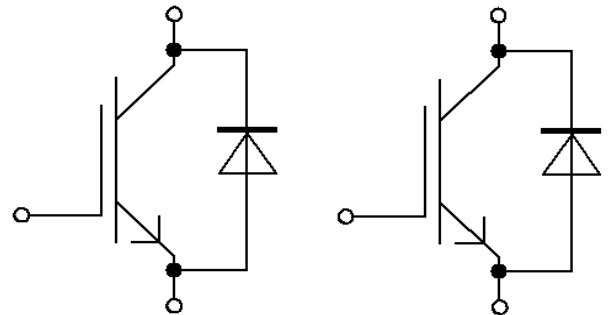
- 中压变流器
- 大功率变流器
- 牵引变流器
- 电机传动
- 风力发电机

#### 电气特性

- $T_{vj\,op} = 150^{\circ}\text{C}$
- 低  $V_{CEsat}$
- 增大的二极管针对反馈运行模式
- 提高工作结温  $T_{vj\,op}$

#### 机械特性

- 4 kV 交流 1分钟 绝缘
- 标准封装
- 碳化硅铝 (AlSiC) 基板提供更高的温度循环能力
- 高功率密度
- 高功率循环和温度循环能力



$$V_{CES} = 1700\text{V}$$

$$I_{C\,nom} = 800\text{A} / I_{CRM} = 1600\text{A}$$

#### Potential Applications

- Medium voltage converters
- High power converters
- Traction drives
- Motor drives
- Wind turbines

#### Electrical Features

- $T_{vj\,op} = 150^{\circ}\text{C}$
- Low  $V_{CEsat}$
- Enlarged diode for regenerative operation
- Extended operating temperature  $T_{vj\,op}$

#### Mechanical Features

- 4 kV AC 1min insulation
- Standard housing
- AlSiC base plate for increased thermal cycling capability
- High power density
- High power and thermal cycling capability

### Module Label Code

Barcode Code 128



DMX - Code



#### Content of the Code

| Content of the Code        | Digit   |
|----------------------------|---------|
| Module Serial Number       | 1 - 5   |
| Module Material Number     | 6 - 11  |
| Production Order Number    | 12 - 19 |
| Datecode (Production Year) | 20 - 21 |
| Datecode (Production Week) | 22 - 23 |

## IGBT, 逆变器 / IGBT, Inverter

## 最大额定值 / Maximum Rated Values

|                                                |                                                                                                                              |                    |             |        |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|--------|
| 集电极 - 发射极电压<br>Collector-emitter voltage       | $T_{vj} = 25^{\circ}\text{C}$                                                                                                | $V_{CES}$          | 1700        | V      |
| 连续集电极直流电流<br>Continuous DC collector current   | $T_C = 80^{\circ}\text{C}, T_{vj\max} = 150^{\circ}\text{C}$<br>$T_C = 25^{\circ}\text{C}, T_{vj\max} = 150^{\circ}\text{C}$ | $I_{CDC}$<br>$I_C$ | 800<br>1200 | A<br>A |
| 集电极重复峰值电流<br>Repetitive peak collector current | $t_P = 1\text{ ms}$                                                                                                          | $I_{CRM}$          | 1600        | A      |
| 栅极 - 发射极峰值电压<br>Gate-emitter peak voltage      |                                                                                                                              | $V_{GES}$          | +/-20       | V      |

## 特征值 / Characteristic Values

|                                                       |                                                                                                                                                                                                   |                                                                                                   | min.                | typ.                 | max.                 |                                                 |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------|----------------------|----------------------|-------------------------------------------------|
| 集电极 - 发射极饱和电压<br>Collector-emitter saturation voltage | $I_C = 800\text{ A}$<br>$V_{GE} = 15\text{ V}$                                                                                                                                                    | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $V_{CE\text{ sat}}$ | 1,80<br>2,10<br>2,20 | 2,20<br>2,60<br>2,70 | V<br>V<br>V                                     |
| 栅极阈值电压<br>Gate threshold voltage                      | $I_C = 32,0\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25^{\circ}\text{C}$                                                                                                                              |                                                                                                   | $V_{GEth}$          | 5,20                 | 5,80                 | 6,40 V                                          |
| 栅极电荷<br>Gate charge                                   | $V_{GE} = -15 / 15\text{ V}$                                                                                                                                                                      |                                                                                                   | $Q_G$               | 8,30                 |                      | $\mu\text{C}$                                   |
| 内部栅极电阻<br>Internal gate resistor                      | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                                                     |                                                                                                   | $R_{Gint}$          | 1,9                  |                      | $\Omega$                                        |
| 输入电容<br>Input capacitance                             | $f = 1000\text{ kHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$                                                                                                     |                                                                                                   | $C_{ies}$           | 65,0                 |                      | nF                                              |
| 反向传输电容<br>Reverse transfer capacitance                | $f = 1000\text{ kHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$                                                                                                     |                                                                                                   | $C_{res}$           | 2,10                 |                      | nF                                              |
| 集电极-发射极截止电流<br>Collector-emitter cut-off current      | $V_{CE} = 1700\text{ V}, V_{GE} = 0\text{ V}, T_{vj} = 25^{\circ}\text{C}$                                                                                                                        |                                                                                                   | $I_{CES}$           |                      | 5,0                  | mA                                              |
| 栅极-发射极漏电流<br>Gate-emitter leakage current             | $V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}, T_{vj} = 25^{\circ}\text{C}$                                                                                                                          |                                                                                                   | $I_{GES}$           |                      | 400                  | nA                                              |
| 开通延迟时间(电感负载)<br>Turn-on delay time, inductive load    | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}$<br>$V_{GE} = -15 / 15\text{ V}$<br>$R_{Gon} = 0,8\ \Omega$                                                                                            | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $t_{don}$           | 0,59<br>0,63<br>0,64 |                      | $\mu\text{s}$<br>$\mu\text{s}$<br>$\mu\text{s}$ |
| 上升时间(电感负载)<br>Rise time, inductive load               | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}$<br>$V_{GE} = -15 / 15\text{ V}$<br>$R_{Gon} = 0,8\ \Omega$                                                                                            | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $t_r$               | 0,14<br>0,16<br>0,16 |                      | $\mu\text{s}$<br>$\mu\text{s}$<br>$\mu\text{s}$ |
| 关断延迟时间(电感负载)<br>Turn-off delay time, inductive load   | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}$<br>$V_{GE} = -15 / 15\text{ V}$<br>$R_{Goff} = 1,8\ \Omega$                                                                                           | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $t_{doff}$          | 1,00<br>1,15<br>1,15 |                      | $\mu\text{s}$<br>$\mu\text{s}$<br>$\mu\text{s}$ |
| 下降时间(电感负载)<br>Fall time, inductive load               | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}$<br>$V_{GE} = -15 / 15\text{ V}$<br>$R_{Goff} = 1,8\ \Omega$                                                                                           | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $t_f$               | 0,32<br>0,50<br>0,55 |                      | $\mu\text{s}$<br>$\mu\text{s}$<br>$\mu\text{s}$ |
| 开通损耗能量(每脉冲)<br>Turn-on energy loss per pulse          | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}, L\sigma = 50\text{ nH}$<br>$V_{GE} = -15 / 15\text{ V}, R_{Gon} = 0,8\ \Omega$                                                                        | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $E_{on}$            | 145<br>215<br>245    |                      | mJ<br>mJ<br>mJ                                  |
| 关断损耗能量(每脉冲)<br>Turn-off energy loss per pulse         | $I_C = 800\text{ A}, V_{CE} = 900\text{ V}, L\sigma = 50\text{ nH}$<br>$du/dt = 3300\text{ V}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$<br>$V_{GE} = -15 / 15\text{ V}, R_{Goff} = 1,8\ \Omega$ | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $E_{off}$           | 255<br>330<br>365    |                      | mJ<br>mJ<br>mJ                                  |
| 短路数据<br>SC data                                       | $V_{GE} \leq 15\text{ V}, V_{CC} = 1000\text{ V}$<br>$V_{CEmax} = V_{CES} - L_{SCE} \cdot di/dt$<br>$t_P \leq 10\ \mu\text{s}, T_{vj} = 150^{\circ}\text{C}$                                      |                                                                                                   | $I_{SC}$            | 3400                 |                      | A                                               |
| 结 - 外壳热阻<br>Thermal resistance, junction to case      | 每个 IGBT / per IGBT                                                                                                                                                                                |                                                                                                   | $R_{thJC}$          |                      | 25,7                 | K/kW                                            |
| 外壳 - 散热器热阻<br>Thermal resistance, case to heatsink    | 每个 IGBT / per IGBT<br>$\lambda_{\text{Paste}} = 1\text{ W}/(\text{m}\cdot\text{K}) / \lambda_{\text{grease}} = 1\text{ W}/(\text{m}\cdot\text{K})$                                                |                                                                                                   | $R_{thCH}$          | 22,8                 |                      | K/kW                                            |
| 在开关状态下温度<br>Temperature under switching conditions    |                                                                                                                                                                                                   |                                                                                                   | $T_{vj\text{ op}}$  | -40                  | 150                  | $^{\circ}\text{C}$                              |

## 二极管, 逆变器 / Diode, Inverter

## 最大额定值 / Maximum Rated Values

|                                             |                                                                                                                                              |               |            |                                                |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|------------------------------------------------|
| 反向重复峰值电压<br>Repetitive peak reverse voltage | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                | $V_{RRM}$     | 1700       | V                                              |
| 连续正向直流电流<br>Continuous DC forward current   |                                                                                                                                              | $I_F$         | 800        | A                                              |
| 正向重复峰值电流<br>Repetitive peak forward current | $t_P = 1\text{ ms}$                                                                                                                          | $I_{FRM}$     | 1600       | A                                              |
| $I^2t$ -值<br>$I^2t$ - value                 | $V_R = 0\text{ V}, t_P = 10\text{ ms}, T_{vj} = 125^{\circ}\text{C}$<br>$V_R = 0\text{ V}, t_P = 10\text{ ms}, T_{vj} = 150^{\circ}\text{C}$ | $I^2t$        | 240<br>210 | $\text{kA}^2\text{s}$<br>$\text{kA}^2\text{s}$ |
| 最大损耗功率<br>Maximum power dissipation         | $T_{vj} = 150^{\circ}\text{C}$                                                                                                               | $P_{RQM}$     | 1200       | kW                                             |
| 最小开通时间<br>Minimum turn-on time              |                                                                                                                                              | $t_{on\ min}$ | 10,0       | $\mu\text{s}$                                  |

## 特征值 / Characteristic Values

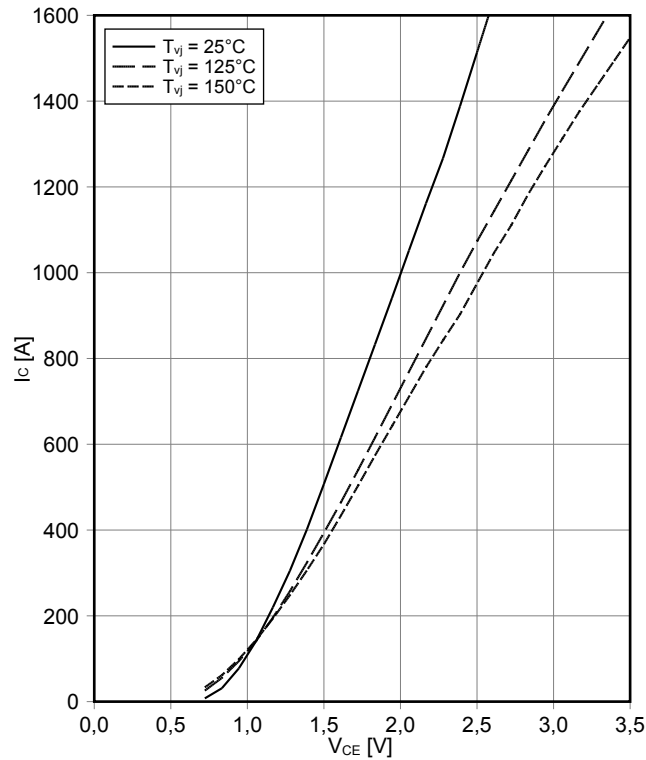
|                                                    |                                                                                                                                                     |                                                                                                   | min.         | typ. | max.                 |                                                 |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------|------|----------------------|-------------------------------------------------|
| 正向电压<br>Forward voltage                            | $I_F = 800\text{ A}, V_{GE} = 0\text{ V}$<br>$I_F = 800\text{ A}, V_{GE} = 0\text{ V}$<br>$I_F = 800\text{ A}, V_{GE} = 0\text{ V}$                 | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $V_F$        |      | 1,55<br>1,60<br>1,65 | 2,00<br>2,05<br>2,10<br>V<br>V<br>V             |
| 反向恢复峰值电流<br>Peak reverse recovery current          | $I_F = 800\text{ A}, -di_F/dt = 5600\text{ A}/\mu\text{s} (T_{vj}=150^{\circ}\text{C})$<br>$V_R = 900\text{ V}$<br>$V_{GE} = -15\text{ V}$          | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $I_{RM}$     |      | 1000<br>1150<br>1200 | A<br>A<br>A                                     |
| 恢复电荷<br>Recovered charge                           | $I_F = 800\text{ A}, -di_F/dt = 5600\text{ A}/\mu\text{s} (T_{vj}=150^{\circ}\text{C})$<br>$V_R = 900\text{ V}$<br>$V_{GE} = -15\text{ V}$          | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $Q_r$        |      | 240<br>410<br>450    | $\mu\text{C}$<br>$\mu\text{C}$<br>$\mu\text{C}$ |
| 反向恢复损耗 (每脉冲)<br>Reverse recovery energy            | $I_F = 800\text{ A}, -di_F/dt = 5600\text{ A}/\mu\text{s} (T_{vj}=150^{\circ}\text{C})$<br>$V_R = 900\text{ V}$<br>$V_{GE} = -15\text{ V}$          | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $E_{rec}$    |      | 160<br>280<br>325    | mJ<br>mJ<br>mJ                                  |
| 结 - 外壳热阻<br>Thermal resistance, junction to case   | 每个二极管 / per diode                                                                                                                                   |                                                                                                   | $R_{thJC}$   |      |                      | 36,8<br>K/kW                                    |
| 外壳 - 散热器热阻<br>Thermal resistance, case to heatsink | 每个二极管 / per diode<br>$\lambda_{\text{Paste}} = 1\text{ W}/(\text{m}\cdot\text{K})$ / $\lambda_{\text{grease}} = 1\text{ W}/(\text{m}\cdot\text{K})$ |                                                                                                   | $R_{thCH}$   |      | 30,0                 | K/kW                                            |
| 在开关状态下温度<br>Temperature under switching conditions |                                                                                                                                                     |                                                                                                   | $T_{vj\ op}$ | -40  | 150                  | $^{\circ}\text{C}$                              |

## 模块 / Module

|                                                          |                                                                                |                      |              |      |         |
|----------------------------------------------------------|--------------------------------------------------------------------------------|----------------------|--------------|------|---------|
| 绝缘测试电压<br>Isolation test voltage                         | RMS, f = 50 Hz, t = 1 min.                                                     | V <sub>ISOL</sub>    | 4,0          | kV   |         |
| 模块基板材料<br>Material of module baseplate                   |                                                                                |                      | AlSiC        |      |         |
| 内部绝缘<br>Internal isolation                               | 基本绝缘 (class 1, IEC 61140)<br>basic insulation (class 1, IEC 61140)             |                      | AlN          |      |         |
| 爬电距离<br>Creepage distance                                | 端子至散热器 / terminal to heatsink<br>端子至端子 / terminal to terminal                  |                      | 15,0<br>15,0 | mm   |         |
| 电气间隙<br>Clearance                                        | 端子至散热器 / terminal to heatsink<br>端子至端子 / terminal to terminal                  |                      | 10,0<br>10,0 | mm   |         |
| 相对电痕指数<br>Comperative tracking index                     |                                                                                | CTI                  | > 600        |      |         |
|                                                          |                                                                                |                      |              |      |         |
|                                                          |                                                                                |                      | min.         | typ. | max.    |
| 杂散电感,模块<br>Stray inductance module                       |                                                                                | L <sub>sCE</sub>     |              | 20   | nH      |
| 模块引线电阻,端子-芯片<br>Module lead resistance, terminals - chip | T <sub>C</sub> = 25°C, 每个开关 / per switch                                       | R <sub>CC'+EE'</sub> |              | 0,33 | mΩ      |
| 储存温度<br>Storage temperature                              |                                                                                | T <sub>stg</sub>     | -40          |      | 125 °C  |
| 模块安装的安装扭矩<br>Mounting torque for modul mounting          | 螺丝 M6 根据相应的应用手册进行安装<br>Screw M6 - Mounting according to valid application note | M                    | 4,25         |      | 5,75 Nm |
| 端子联接扭矩<br>Terminal connection torque                     | 螺丝 M4 根据相应的应用手册进行安装<br>Screw M4 - Mounting according to valid application note | M                    | 1,8          | -    | 2,1 Nm  |
|                                                          | 螺丝 M8 根据相应的应用手册进行安装<br>Screw M8 - Mounting according to valid application note |                      | 8,0          | -    | 10 Nm   |
| 重量<br>Weight                                             |                                                                                | G                    |              | 920  | g       |

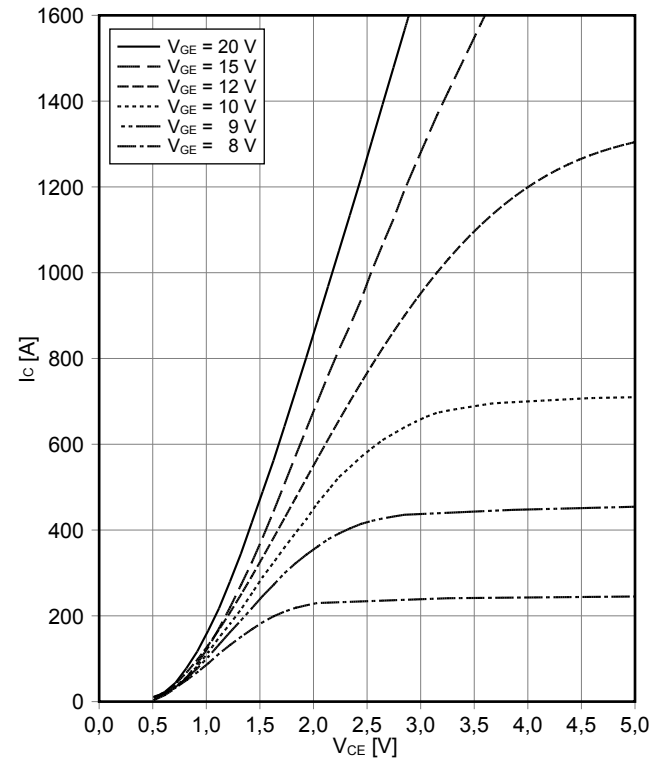
输出特性 IGBT, 逆变器 (典型)

output characteristic IGBT, Inverter (typical)

 $I_C = f(V_{CE})$   
 $V_{GE} = 15\text{ V}$ 


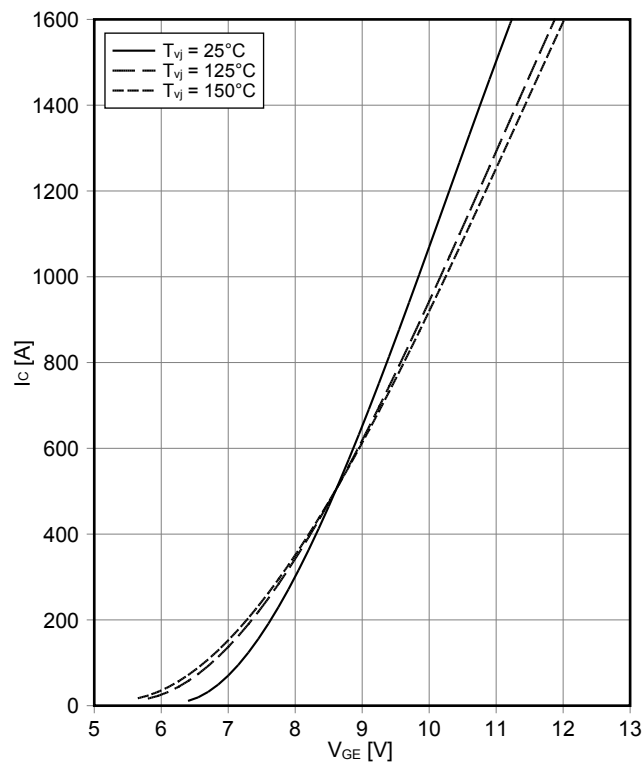
输出特性 IGBT, 逆变器 (典型)

output characteristic IGBT, Inverter (typical)

 $I_C = f(V_{CE})$   
 $T_{vj} = 150^\circ\text{C}$ 


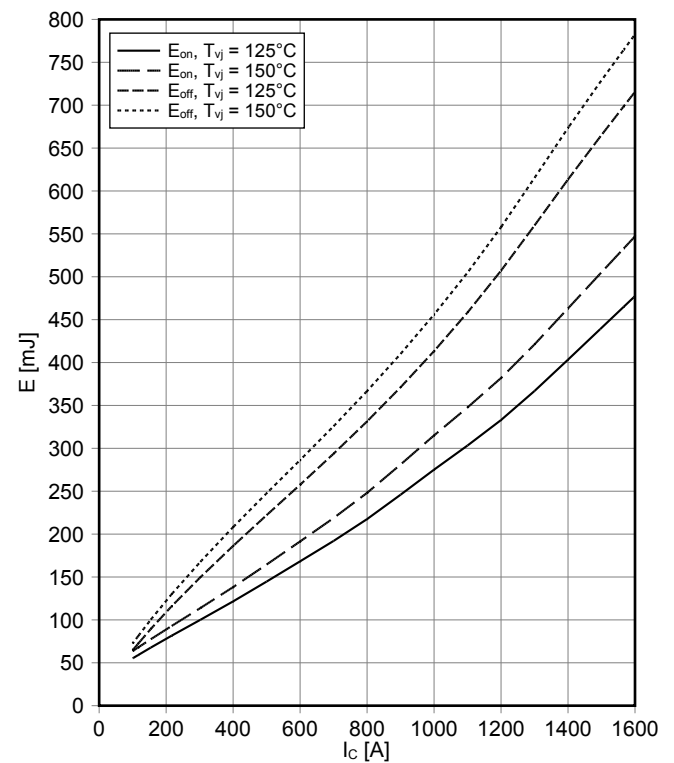
传输特性 IGBT, 逆变器 (典型)

transfer characteristic IGBT, Inverter (typical)

 $I_C = f(V_{GE})$   
 $V_{CE} = 20\text{ V}$ 


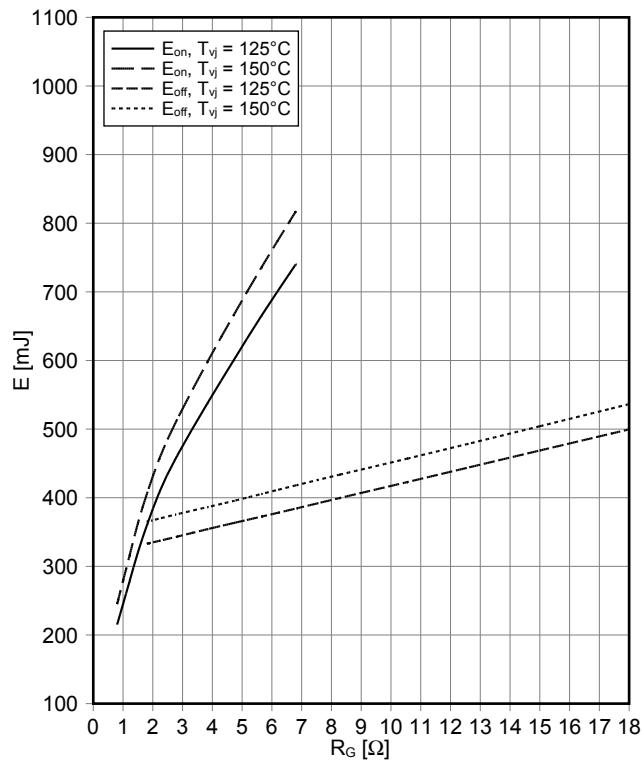
开关损耗 IGBT, 逆变器 (典型)

switching losses IGBT, Inverter (typical)

 $E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$   
 $V_{GE} = \pm 15\text{ V}$ ,  $R_{Gon} = 0.8\ \Omega$ ,  $R_{Goff} = 1.8\ \Omega$ ,  $V_{CE} = 900\text{ V}$ 


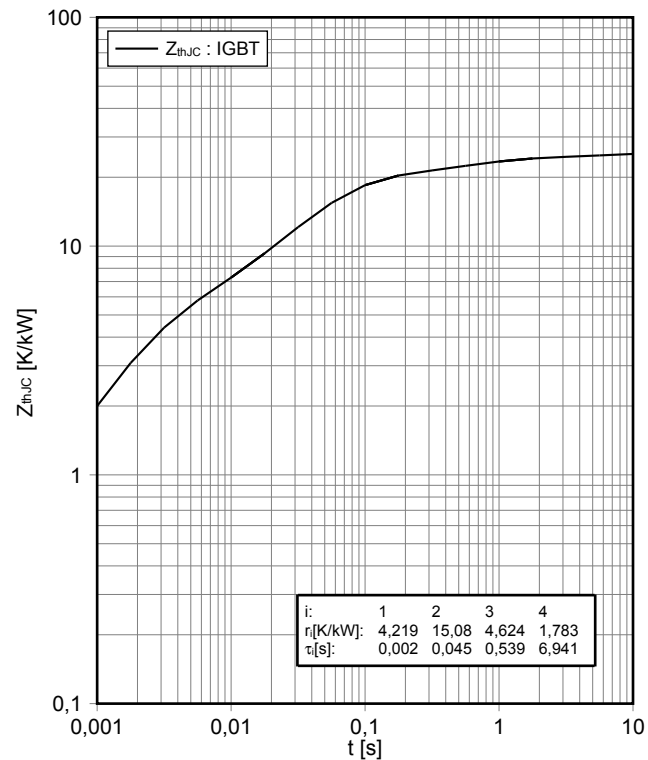
## 开关损耗 IGBT, 逆变器 (典型) switching losses IGBT, Inverter (typical)

$E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$   
 $V_{GE} = \pm 15 \text{ V}$ ,  $I_C = 800 \text{ A}$ ,  $V_{CE} = 900 \text{ V}$



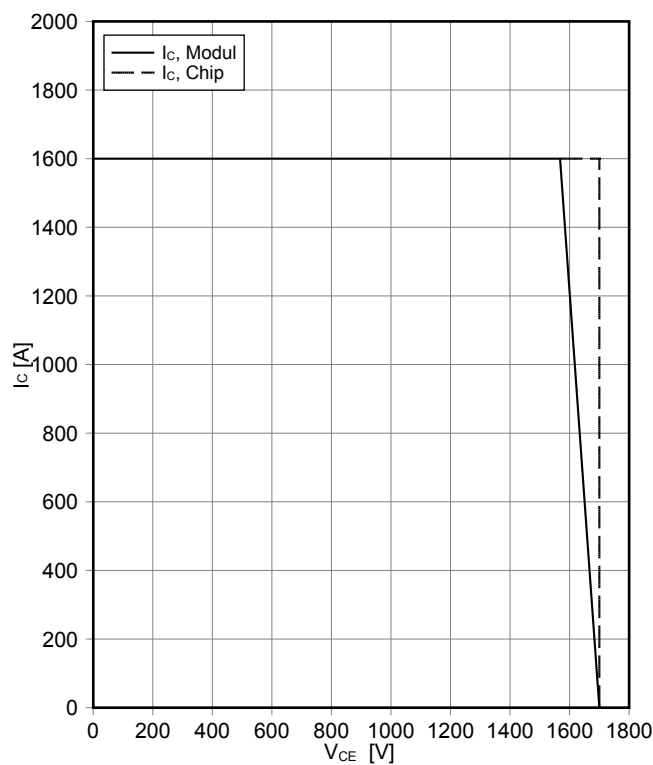
## 瞬态热阻抗 IGBT, 逆变器 transient thermal impedance IGBT, Inverter

$Z_{thJC} = f(t)$



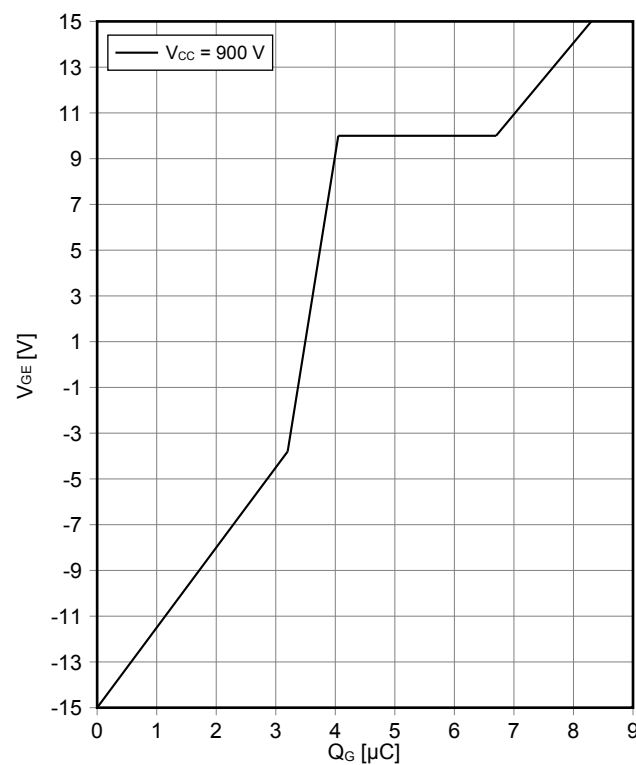
## 反偏安全工作区 IGBT, 逆变器 (RBSOA) reverse bias safe operating area IGBT, Inverter (RBSOA)

$I_C = f(V_{CE})$   
 $V_{GE} = \pm 15 \text{ V}$ ,  $R_{Goff} = 1.8 \Omega$ ,  $T_{vj} = 150^\circ C$

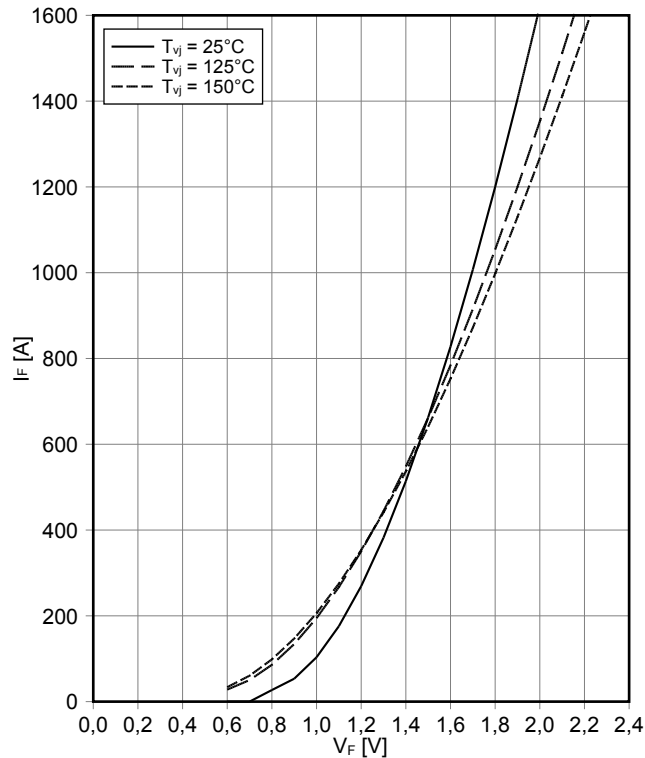


## 栅极电荷特性 IGBT, 逆变器 (典型) gate charge characteristic IGBT, Inverter (typical)

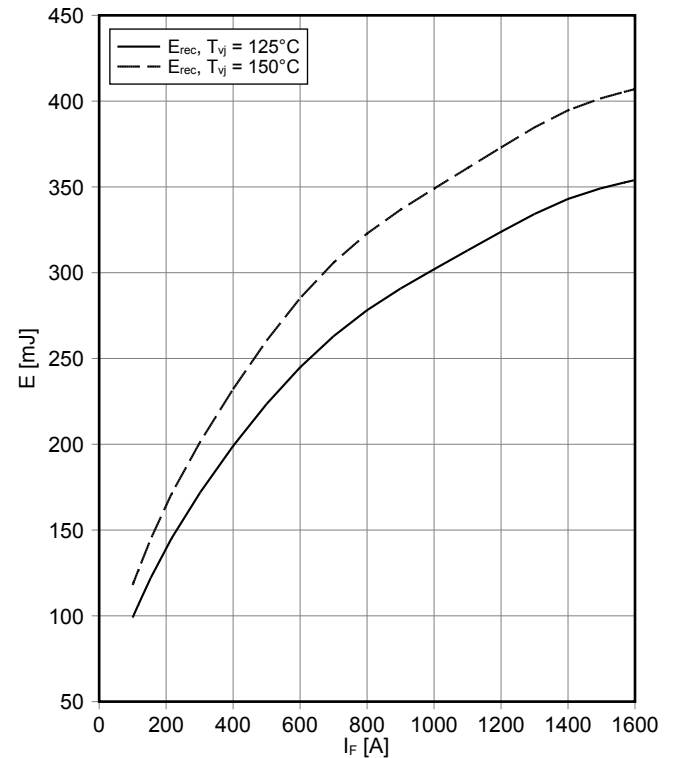
$V_{GE} = f(Q_G)$   
 $I_C = 800 \text{ A}$ ,  $T_{vj} = 25^\circ C$



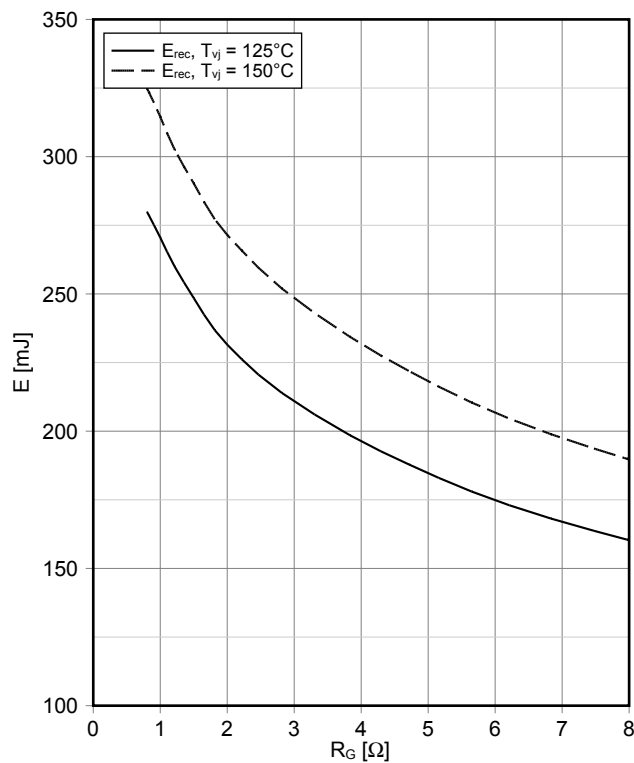
正向偏压特性 二极管,逆变器 (典型)  
**forward characteristic of Diode, Inverter (typical)**  
 $I_F = f(V_F)$



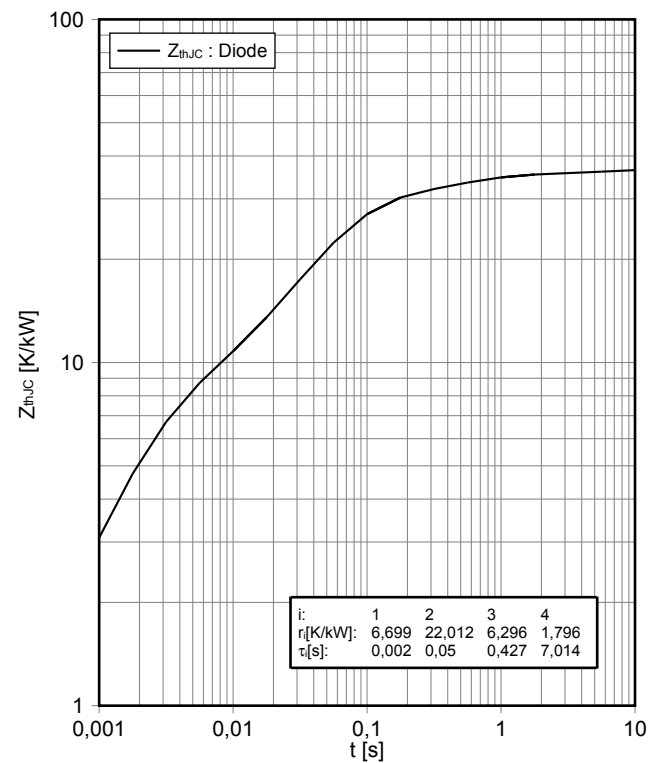
开关损耗 二极管,逆变器 (典型)  
**switching losses Diode, Inverter (typical)**  
 $E_{rec} = f(I_F)$   
 $R_{Gon} = 0.8 \Omega$ ,  $V_{CE} = 900 V$



开关损耗 二极管,逆变器 (典型)  
**switching losses Diode, Inverter (typical)**  
 $E_{rec} = f(R_G)$   
 $I_F = 800 A$ ,  $V_{CE} = 900 V$



瞬态热阻抗 二极管,逆变器  
**transient thermal impedance Diode, Inverter**  
 $Z_{thJC} = f(t)$

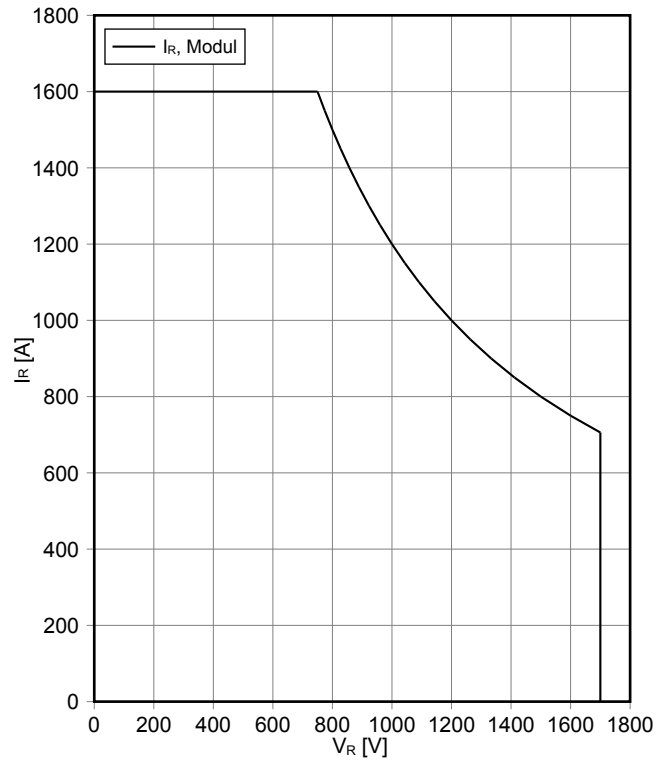


安全工作区 二极管,逆变器 (SOA)

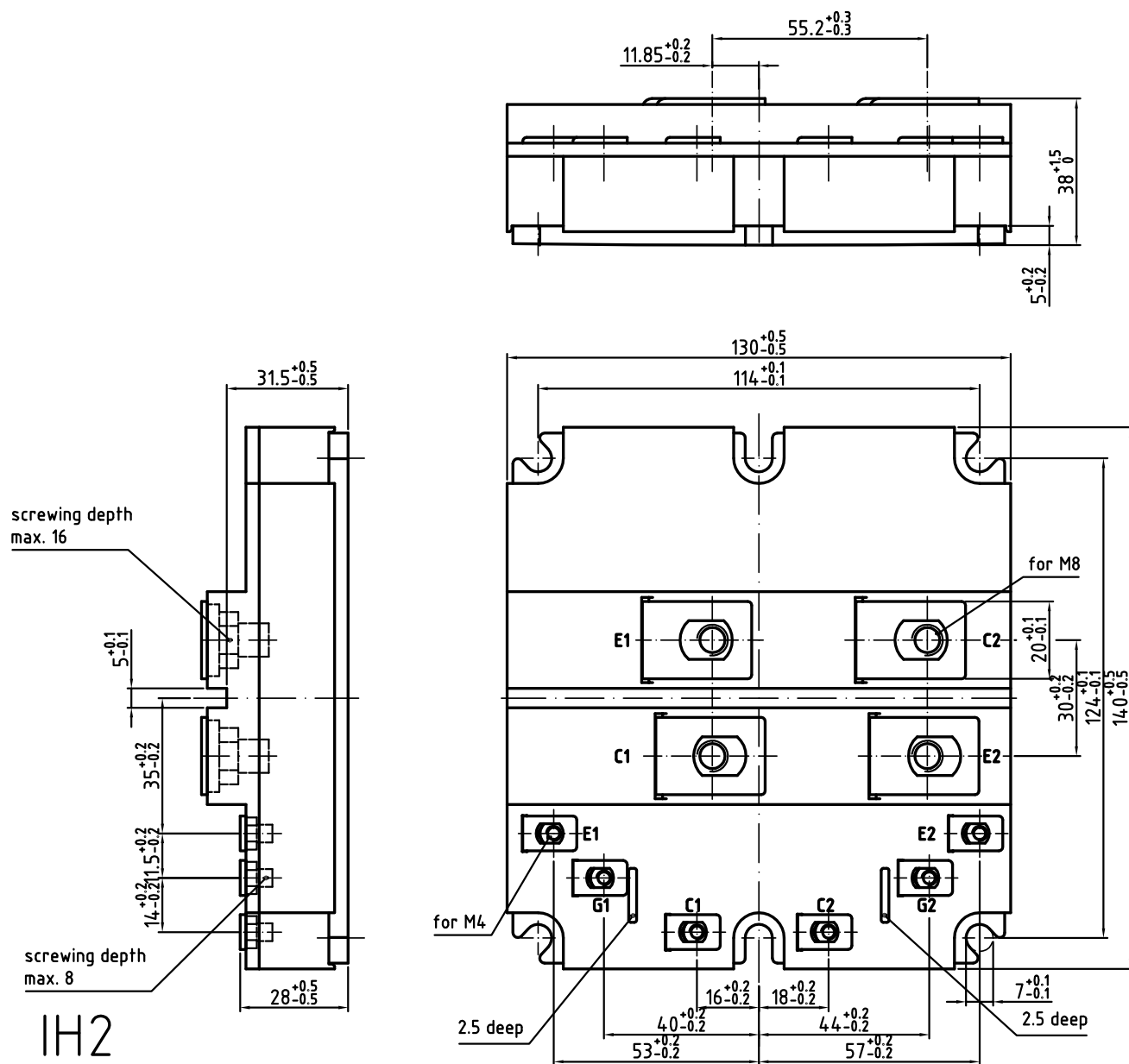
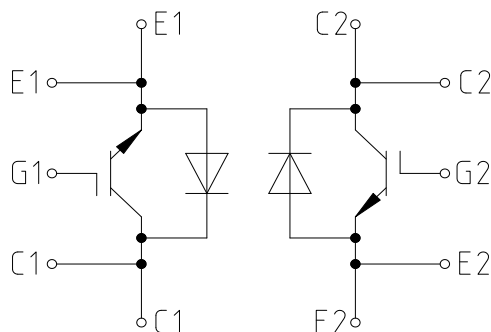
safe operation area Diode, Inverter (SOA)

$I_R = f(V_R)$

$T_{vj} = 150^\circ\text{C}$







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